Roads and development = environment and energy?

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Abstract: Investment in large-scale infrastructure, after a lull, has accelerated in the last decade, where roads in particular feature predominantly in development initiatives globally. While conventionally academic interventions have primarily focused on infrastructure in relation to economic development processes and its promises of modernity, more recently these arguments extended to diverse processes of environmental, economic, political and social change. Scepticism surrounding road infrastructure development interrogates whether this form of infrastructure development is justifiable. In particular the faith placed on roads to catalyse trade, create profitability, enhance economic opportunities of local communities living adjacent to new road infrastructure projects and its ability to mitigate environmental concerns are noted concerns. Our review draws together and extends these arguments, claiming that while social, political and economic processes and consequences of road development have undergone recurrent assessment, gaps in addressing environmental and energy aspects prevail. Given the central import of climate and environmental change at the current juncture, thus, there is also a pressing need to articulate and examine this in future work.

Key words: roads, infrastructure, development, environment, energy

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The Authors declares that there is no conflict of interest

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1. Introduction

Road infrastructure has witnessed considerable changes in the past decades and centuries, transforming from mud tracks to asphalt roads, which has been advocated vigorously by policy makers and development agencies. They have argued for accelerations in rural road infrastructure as the basis for leading to better connectivity, accessibility and economic growth. However, this hubris in infrastructure led development needs to be tempered, as not everyone benefits as equally as envisioned; settlements are moved and houses torn down to make way for new roads, signalling the disruption and displacement that infrastructure brings with it (Colombijn, 2002; Masquelier, 2002; Klaeger, 2009; Porter, 1997). Critics have exposed the vulnerability of this development vision, with arguments ranging from the low-income being unable to afford tolls to the poor being disconnected from the benefits of accessibility and economic growth (Anand, 2006; Estache et al., 2000). These arguments are not unfamiliar today, with social justice and environmental issues so central that neglecting them is not possible. Thus road infrastructure continues to be a theoretically productive concept for analysing debates in developmental studies, headlining its intrinsic connections to resource, economic, socio-cultural, political and environmental issues (Anand, 2006; Perreault, 2009; Wilson, 2004). This intervention has the potential to stimulate

distinct analytical possibilities for development studies to address instabilities inherent to infrastructure, and highlight movement, contingency, process, and conflict through its study.

The linkages between infrastructure and economic development highlighted above has been supported by research, which has mainly focussed on infrastructure in relation to economic development processes and a quest for modernity (Ioris, 2010; Perreault, 2006; Staddon 2009). This has more recently been picked up as signalling compressing time-space, connectivity, communication and circulation in diverse processes of environmental, economic, political, cultural and social change (Beckman, 2001; Wilson, 2004; Anand, 2006; Harrowell, 2015). These recent interventions suggest that connectivity and economic circulation also has spill over effects on the socio-political and environmental realms, which are increasingly hard to neglect.

All these contributors hence suggest that there are three main spheres of interdependence: conceptual, methodological and finally, evidence-led. In this review, we focus on these contributions within the domain of road infrastructure and pick out some key themes and gaps in recent road development literature, with particular emphasis on economic, social and environmental issues. We start by discussing scholarship that assesses linkages between infrastructure development and strategies to enhance economic growth and reduce socio-spatial inequalities. Then we turn to mapping the trajectories of road development and its implications upon demographic movement, mobility and accessibility. Finally the review examines the literature on the entangled flows between roads, environment and energy, with a view to pointing to the lacuna in the literature.

2. Roads and Development

Economic claims have dominated theories attempting to trace the synergy between roads and development for five decades or more (Allal and Edmonds, 1977; ILO, 1963). Roads are perceived to connect countries and open up landlocked areas to market competition, resulting in economic and social integration and lowering trade barriers (Harvey and Knox, 2008; Moran, 2009; Sahoo and Dash, 2012). How the World Bank (1996) lending is heavily biased towards infrastructural investment offers credence

to these arguments; where road building projects feature prominently with an unalloyed optimism to bring development, whether in the Northern or Southern hemisphere (Bryceson et al., 2008; Moran, 2009; Porter, 2007). More recently, however, there seems to have been a reassessment of road use as a component in development assistance. While the initial vision has been discredited due to its simplicity and linearity, the perception that roads are key to progressing economic development has prevailed (Allal and Edmonds, 1977; De Veen 1980; Harvey and Knox, 2015; Howe and Richards, 1984; World Bank, 1996). The relationship between roads and development have been studied by a number of scholars for over six decades (Geddes, 1940; Hirschmann, 1958; Rostow, 1962), and their claims are reflected in the early biases in multi-lateral development priorities in the post-war and post-independence years. Subsequent interest in road infrastructure has tended to be a subset of a vast, mostly technical literature on road feasibility and impact in countries (Allal and Edmonds, 1977; Bryceson et al., 2008; Bell, 2012; De Veen, 1980; Howe, 1997; ILO, 1963; Roseman, 1996). Even though the studies moved away from the overconcentration on economic benefits to social profitability, these academic interventions signal how roads were the preserve of engineers and transport specialist. Yet, over time road infrastructure has become an emergent field for others, including human geographers, anthropologist, sociologists and development studies scholars, with much of this scholarship tracing connections between road infrastructure and neo-liberal exigencies (Anand, 2006; Dalakoglou, 2010; Harvey and Knox, 2015; Klaeger, 2009; Masquelier, 2002; Trankell, 1993; Wilson, 2004).

While the relationship between infrastructure and economic growth has been controversial, a number of empirical studies have established high returns to infrastructure investment (Easterly and Rebelo, 1993; Limão and Venables 2001). A series of country-level studies demonstrate that infrastructure has a positive and significant impact on economic growth.[1] How roads provides increased access to both traded inputs and the possibility to transport agricultural products to distant markets, thus

[1] For example see Uchimura and Gao (1993) for Korea, China, and Taiwan, Shah (1992) for Mexico and Fedderke and Bogetić (2009) for South Africa.

allowing cash cropping to replace subsistence farming, are some benefits traced (Rudel and Richards, 1990; Wasike, 2001).[2]

Road infrastructure also provides the opportunity for the expansion of non-agricultural economic activities. This may take the form of the construction and maintenance of the road, which can act to transfer new and valuable skills into the community. Various technical studies conducted in a number of developing countries, including India, Bangladesh, Kenya, Philippines, have suggested that proper planning and management of road construction can utilize surplus labour and thereby address social mobility within these countries (Allal and Edmonds, 1977; Howe and Richards 1984; Howe 1997; ILO, 1963). Economic opportunities also emerge with roads in a complex economy of services, trade and exchange; which may take the form of commercial taxi or lorry drivers, "fare collectors for bush taxis, spare parts salesmen, mechanics, black-market money traders, food vendors, motor car guards, drifters" (Masquelier, 2002: 836; see also Klaeger, 2009). These contributions underscore the centrality of mobility, in particular for "farming communities threatened by land shortages, soil degradation, and periodic droughts" (Masquelier 2002:84). Additionally, Porter (1995) notes that the presence of construction teams for the road can stimulate new markets alongside it, which can be extended once the road is opened. Mandel (2006) examines how road infrastructure potentially benefits local market trade through its enhancement of spatial mobility, by examining livelihoods of women in Porto Novo, Benin, where mobility is crucial for economic success by connecting them to external suppliers.

The above narrative, however, is contested. There is no consensus on precisely how roads are critical to economic growth and if they actually warrant the faith vested in them. Questions around faith placed in road and its ability to catalyse trade (Limão and Venables, 2001), create profitability (Silas, 2002; Colombijn, 2002; Khan, 2006), and enhance the economic opportunities for local communities are all recorded (Porter, 1995, 1997; Masquelier, 2002; Porath, 2002; Klaeger, 2009). Colombijn (2002), for example, has labelled the wave of confidence in road infrastructure as a "seemingly blind enthusiasm", which is "largely unquestioned" (2002:595-606). Such scepticism has foreseen an emergence of

[2] Wasike (2001) offers many illustration to support this point; the most revealing is the road projects in Uganda, which led to an ex-post increase in cotton production of 200–700% with a corresponding rise in income of 373–525%.

scholarship that aims to extract the extent to which infrastructure is economically beneficial. An important concern is the endogeneity and the direction of causality between infrastructure and economic development, pointing to a bias towards infrastructure (Esfahani and Ramırez, 2002). Social equity considerations are also raised, with the recognition that "road investments must take into account the need to serve different user groups, including the very poor", who may be unable to afford the road because of tolls or lack of public transport (Estache et al., 2000:9). Anand (2006) shows how world class roads built in Mumbai disconnect millions of people in the city, people with vehicles deemed not fast or modern enough, pedestrians and populations on foot, because of the privileged positioned occupied by those who envision and operationalize these developments. Similarly, Unruh and Shalaby (2012), in their research on road development in Afghanistan, concludes that the road construction process should be more effective so that benefits do not accrue solely to a set of well-placed actors at the expense of a larger population, who are unable to legally, institutionally and physically defend themselves.

The sustainability of a road's profitability is interconnected to its maintenance of its condition, an aspect often overlooked during road construction (Colombijn, 2002). While the country as a whole generally pays for rural road improvements, external financiers are often reluctant to fund maintenance costs, placing pressure upon local communities that rarely have sufficient funds available (Cook, 1985). Porter (2007) in her study of road transport in Africa argues that although donors and Governments continue to support expansion and maintenance of the road networks, many have become wary of major capital investments in roads, as issues of "inadequate maintenance, inadequate institutions, ingrained corruption and negative consequences for the poor became increasingly and embarrassingly apparent" (2007:255).

In the context of growing concern with the impoverishing effects of uneven spatial development, rural roads are accorded the even more ambitious brief of poverty reduction (Bebbington, 1999; Ellis, 1998; Porter, 2002; Wilson, 2004). Minot et al. (2003) have argued that physical isolation sustains poverty and accentuates vulnerability, with rural road investment logically assumed to alleviate poverty associated with spatial isolation. While there is an expanse of literature based on the economic implications of roads for those within its immediate vicinity, the impacts for off-road communities are rarely analysed. Even

though road construction is associated with demographic shifts, substantial populations remain off-road. It is only a few exceptional studies that have studied how road construction has a bearing on these communities (Airey, 1985; Colombijn, 2002; Pandya, 2002; Porath, 2002). Bryceson et al. (2008) in their study of local communities in Ethiopia, Zambia and Vietnam argue that road development in the absence of mobility enhancement cannot achieve poverty reduction. Furthermore, these communities find themselves more isolated, excluded and neglected than before; and often renders them, the least mobile, most disadvantaged and thus likely to face declining prospects to access the market (Porter, 1995, 1997; Witcher, 1996).[3]

The dominant case for road building from an economic development viewpoint has been the central focus, making it evident why nations continue embrace this form of infrastructure. Yet, while there may be economic advantages associated with road infrastructure, these are not necessarily felt by local and poor communities in the area, begging relevant questions of its distributive boons. The next section unpack these themes further by examining how the state and non-state dedicate much time and energy to road building, even though for many local communities these may potentially lead to loss of land, community control and greater impoverishment.

3. Trajectories of road infrastructure

In contrast to the early faith placed on road infrastructure to act as a catalyst for economic development, more recently interventions have concerned itself with the sociology of road development, inclusive of its implications upon social justice issues including but not limited to demographic movement, mobility and accessibility (Khan, 2006; Bryceson et al, 2008; Harvey and Knox, 2008). This section underscores how local communities' rights to their residential spaces and resources come under stress due to road construction in the name of development and consequently become a point of conflict (Chi, 2012; Cook,

[3] Where roads conversely may lead to or exacerbate isolation of communities, the added challenge is around assessing this situation methodologically – which if novelty and creativity are to be used may mean mapping transport routes of vehicle owners.

1985; Gellert and Lynch, 2003; Harrowell, 2015; Perreault, 2006; Perz et al., 2010; Wasike, 2001). They all illustrate that these tensions and issues can take complex and myriad of forms and be of significant scale and fundamentally matter for social justice reasons.

Forced resettlement of the local population, whose housing and amenities are demolished in order to make way for the road's desirable route, is the most controversial manifestation of infrastructure-human conflict (Wasike, 2001). Lanjouw *et al* (2000) illustrates how in Burma, present day Myanmar, almost a quarter of the urban population was relocated or resettled by its government for purposes of land development, planning and other urban works, including road construction and urban beautification. This also accelerated forced relocation of poor communities to new and unprepared relocation sites, which was combined with military heavy-handedness to impose law and order in the newly settled areas (*ibid).* Another case study by Jayawardena (2011), with regards to the E01 Highway opened in November 2011, linking Colombo (its capital) to Galle via Kottawa, reiterates the same. While the Sri Lankan media generally welcomed the highway with enthusiasm, branding it as the 'Gateway to Wonder' and the 'expressway from tomorrow' (Daily News, 2011), it displaces the scale of associated resettlement. The conservative estimated 1,338 families displaced, translating into 5,300 children, women and men at four members per family, are erased from this narrative of wonder and hope (Jayawardena, 2011). Gellert and Lynch (2003) argue that this type of involuntary displacement is central to the modern ideologies of colonial, state socialist, and capitalist states, whereby "individuals must sacrifice themselves for the public good, which is based on economic notions of average individual utility" (2003:20). Similarly, Colombijn (2002) notes that without such resettlement, road construction, and its associated connotations of modernisation, would be 'almost impossible' (2002: 611). He provides the example of the six-lane through fare in Bangkok, which stops suddenly at the point at which a single man refused to sell his property. This argument of demographic displacement and sacrifice is encapsulated in multiple case studies from Myanmar to Peru – and those in between, Kyrgyzstan, Thailand or Sri Lanka. These cases show how roads as everyday informal spaces that people use, "are saturated with narratives of memory; narratives that ... residents respond to in different ways as they interact with the spaces" that are often ignored (Harrowell, 2015:221). The current privileging of accessibility partly reflects the unproblematic

way that road infrastructure is envisioned and implemented, particularly because these visions may not always resonate with local populations – although there are other instances in which they may.

Demographic movement associated with road infrastructure is not unidirectional; to continue to the stage of road construction, while there is displacement of the local population away from the site, there is also migration of project labour (Gellert and Lynch, 2003). This movement has an impact on both the local community as well as the migrant labourers, who would be dependent on the cooperation of the local community. Wilson (2004) exposes these tensions by illustrating how in the Tarma province in Peruvian Andes, there was a separation between local communities specializing in the intensive production of food to supply to distant markets and those producing limited surplus food, who were more dependent on earnings from labour migration. While roads and locally owned truck transport were essential for the wellbeing of locals, the lack of roads did not penalize migrant labourers. This illustration pointed to the aspirations of local communities to access the wider economy, society and polity, which reflected the internal dynamics of production, migration, social relations and the negativities associated with in-migration (Harvey and Knox, 2015; Wilson, 2004). Further illustrations from the Naga community, which suffered significant conflict-related displacement in its fight for independence in India and Myanmar, show that their situations been exacerbated in last six years along the Khamti-Tekai road (Lanjouw et al., 2000*)*. The secondary displacement during road building and settled migrants in post-construction phase complicates their conflict-related displacement further. Secondary displacement has ripple effects: people and landscapes further away from the project site experience its consequences later in time. It is subject to greater uncertainty than primary displacement and is therefore less amenable to manage or even envision (Gellert and Lynch, 2003).

Where there is a demographic growth and in-migration during infrastructural upgrading, there is an established view that rural areas are likely to prosper "due to business investments and the consequent employment opportunities and increased amenities" (Perz et al., 2010:303; Chi, 2012). Bryceson et al. (2008) identifies how rural communities can benefit from the construction of a proximate road in dichotomous ways; through mobility and accessibility enhancement. Road improvements allow the community to travel further, faster, and potentially cheaper; the ability to send a child to a secondary

school or to reach a health centre exemplifies the latter (Cook, 1985). Improved road connections attract better service infrastructure and staffing, it is claimed, thus reducing the need for distant journeys and enhancing accessibility. However, whether roads necessitate higher mobility for local populations needs to be read critically. Transport modal options are necessary to efficiently utilise roads, and is generally dependent on population density and purchasing power of the area (Bryceson et al, 2008). Wilson (2004) further questions whether greater accessibility and connectivity can always be assumed to bring lower transaction costs, greater prosperity and an easier, more secure, way of life for local populations. The counter narrative she presents describes roads as "places of ambush and assault, frequented by delinquents, terrorists, smugglers, drug-dealers; they are the place where deals are done with bad cops" (*ibid*: 544). Thus the success of accessibility depends on existing power relations and how they are negotiated. Porter (2007) argues for diversity of mobility and accessibility needs among different groups of poor people, who unlike the tangible issues, such as number of kilometres of roads inhabited, remain under researched. Additionally, Cook (1985) notes where population movement towards residing nearby roads occur; this clustering is due to new opportunities it may bring about. Yet road infrastructure can also cause out-migration; i.e. roads often channel people from rural to urban spaces. Roads may also act as connecting points between urban nodes, thereby 'passing over' the rural areas with little or no benefits (Perz et al, 2010). In Niger, two major roads acted to "mainly connect large urban centres to the capital or to foreign cities and have done little to enhance rural economies" (Masquelier 2002:844). Harvey and Knox (2008:87) in their study of the interoceanic highway in South America also speak about "mobile labour in the form of itinerant workers", raising non-economic concerns and tensions associated with mobile labour. These included health concerns (including rumours related to a rise of AIDS associated with labour in migration and poor health condition of the workers), to detrimental romantic relationships that led to haemorrhaging of the local women or a proliferation of single mothers and negative impact on the environment (Harvey and Knox, 2008). Whether roads then expand the prospects and opportunities of rural communities and their socio-economic sphere is debatable, with in-migration of project labour or in-settlement creating or heightening local-outsider tensions.

Roads then bring with it upheaval and chaos to local communities, despite their many allures and promises; its construction itself is also not without risks, as is its afterlife. More fundamentally, however, roads unravel prevailing social relations in complex and multifarious ways that planners and policy-makers championing road construction usually shy away from. The contested nature of infrastructure initiatives, however, is not limited to the social domain; increasingly the literal unearthing that road construction brings about has ramifications on the environment and this needs registering. While geographers have already registered the central import of the connection between environment and development (Perreault, 2009), the centrality of infrastructure and environmental politics within this domain is evident – as we review in our penultimate section. Yet the connections to geographies of energy transition outlined by Bridge et al. (2013) to infrastructure development is less examined, although given the recent and purported rationale that roads are also about gaining fuel efficiencies the research lacuna is evident.

4. Environment, Energy and Roads

Environmental concerns have often been the arena where conflicts over the rationale for and direction of development have taken place and, likewise, development ideas have often been invoked in struggle over resources (Bridge and Perreault, 2009; Ioris, 2010; Perreault, 2009; Staddon, 2009). Environmental concerns embody highly uneven relations of social power and in the social remaking that development necessitates, attentiveness to the ways in which the social world is reshaped. While, as Anand (2006) notes that there is disjuncture between development desires and promises and the material effects of chronic socio-spatial inequality with regards to road construction, the provision of infrastructure facilities, whether of roads, water, or gas supply to name a few, in the name of development are domains where conflict and struggles occur for environmental justice reasons (Ioris, 2010; Staddon, 2009; Perrault, 2006).

The link between development and the natural environment have instigated environmental debates (Chopra, 2000; Ioris, 2010), where Perreault (2009) argues that this correlation is based on two

main pillars: "(i) the ways that social groups are dependent upon nature and natural resources for their survival and welfare; and (ii) the environmental transformations that result from resource use and economic activity" (2009:455). While road construction strictly speaking does not fit neatly into either of these pillars, infrastructure more broadly is needed for economic activity – where infrastructure hardware feed into resource use and at the same time use resources in its very construction. Quite literarily roads excavate the environments that it goes through and cause upheaval to people, places and habitat. Roads then are likely to be associated with complex direct, indirect and cumulative environmental consequences, although there is difficulty in determining the exact extent of environmental implications associated with a single road development, despite international development finance integrating environmental impact assessments (Wasike, 2001).

Environment Impact Assessments (EIA) since their introduction in the 1960s has been one such tool used and canvassed by international funder agencies for road projects. EIA procedures and processes have also been adopted by a number of international organizations, such as the United Nations, the Organization for Economic Co-operation and Development (OECD), the European Commission, World Bank and the International Labour Organisation. These have been responsible for the bulk of the EIAs carried out on road projects in developing countries. The critique, however, is that these agencies have either carried out EIAs, with little or no knowledge of the local environment, or according to Westerns standards (Kennedy, 2004). Additionally EIAs are not apolitical and the lengthy technical material, which lie buried in donor reports, further impact their credibility. Equally, one time assessments of these kinds do not do not take consider the effects of many massive infrastructure changes to the sensitive environment of many rural areas.

Howe (1996) presents an example, where he argues that although pilot projects and initial assessments are very much in vogue, road infrastructure investment and planning in countries like Bangladesh are not accorded such environmental priorities. The piecemeal nature of road projects in rural areas provide the explanation for this anomaly, since few are of such small scale that individual effects are insignificant. However, the cumulative environmental impact of whole programmes conducted over decades is another matter. Howe (1996) argues that in rural areas of Bangladesh, roads have consumed at least one per cent of the available cropland. This may seem small, but in a densely populated

and overwhelmingly agricultural country it could support in excess of one million people. The land required for a road is approximately "0.75 ha per km, i.e. one-third right-of-way, two thirds borrow pits" (Merril et al., 1990 in Howe, 1996:31). However, a consequence of the 1987 and 1988 floods in Bangladesh has been to increase the land required in flood-prone areas, since engineers consider embankment heights to be inadequate and the desirable level has been raised from 2m to 3m. Further increases in land-take seem certain, as global warming is now accepted as irreversible and sea levels are expected to rise by between 20-80 cms in the next 100 years (Howe, 1996; Ioris, 2010). Thus a further increase in embankment heights and land take seems inevitable.

Yet because roads conjure up images of various possibilities and desires that development is to deliver, concerns around climate change impact barely registers on policy documents, and where they do the argument is for how roads are likely to reduce congestion and thereby curtail fuel consumption (Anand, 2006; Ranawaka, n.d; Road Development Authority, 2007). By constructing roads, the argument is made that it can act to remove polluting, congested traffic from urban spaces, therefore leading to a reduction in the emissions of some pollutants (Anand, 2006; Wasike, 2001). This, however, is partial advocacy; aside from displacing conversations from the priorities and environmental virtues of public transit, it also neglects how road construction unravels the environmental landscapes.

Building infrastructure itself displaces dirt and substrate; thereby significantly adding to the biological, geological, and physical attributes of the landscape (Gellert and Lynch, 2003). They highlight that faith in technology and the ability to dominate over nature is integral to modernisation ideology and often translates into a "bias toward larger scale on the part of international lending institutions, construction firms, and monumentalist states" (*ibid*:22). Bigger equipment displaces the earth rapidly, which is likely to exacerbate environmental consequences. To add complexity, it is often not just the area surrounding the infrastructure that is strongly affected environmentally; it is extended to areas of borrow pits, deposit pits, material treatment areas, and facilities provided for project workers, which are used (Wasike, 2001). Additionally, road construction to facilitate the opening of new resources frontiers exacerbates environmental burdens – both because of the environmental consequences of the extractive economy and the ecological destruction that road constructions bring along. Roads often accompany

natural resource extraction and export-oriented agroindustry, such as mining, agri-business soy bean production, gas extraction, because they are key to securing these resources – with this holding to be the case from disparate countries as Mongolia, Bolivia and Chile to the Amazonian region (Campbell, 2012; Pederson and Bunkenborg, 2012, Peralta et al, 2015).

In addition to deforestation and land clearance, once roads are built they can also hasten forest destruction further. Access the roads may provide to forests and protected forest cover is likely to lead to an increase in illegal logging – and is recorded in the literature and media (Colombijn, 2002; Harvey and Knox, 2008; 2015). Wadley's (1998) study outlines the effects of a road in West Kalimantan; the influx of newcomers and illegal loggers attracted into the area caused the locals to increased insecurity about the land tenure of forestland, thus leading to the accelerated conversion of forestland into cultivable land (Colombijn, 2002).

To extend the example of road infrastructure and its incursions on the environment a step further, road building in areas that were previously without any roads is to increase the use of motorized vehicles. Howe (1997) has historically criticized the rural roads infrastructure approach that regards non-motorized transport as marginal. He has used environmental and economic reasons to argue against conventional interventions, which support motorised transport system for rural road planning. The automobile has long been known as an environmental concern; Witcher (1996:60) argues it is perceived as a "short sighted assault on the environment", while past arguments, such as Vester's (1990, cited in Beckmann, 2001), thought environmental degradation would limit the expansion of the motorcar. Environmental implications of the automobiles are vast, with Beckmann (2001) noting how the earth's ozone layer is destroyed through the exploitation of resources to produce and use motor vehicles. Meeting the challenges of climate change and energy security is, therefore, fundamentally a geographical project: it not only requires societies to commit massive investment to redesign infrastructure, buildings and equipment, but also to make choices from a range of possible spatial solutions and scales of governance (Bridge et al., 2013). These concerns have received coverage from road engineering studies since 1970s, which spearheaded the environmental and construction methods literature. They criticized mainstream Western transport specialists' technical bias and constructed insightful analyses that took on board the

actual material, economic and social conditions in developing countries with respect to economic, social and environmental goals. They concluded that the rural roads planning in most developing countries has taken insufficient account of the needs and requirements of the bulk of the rural populations, only the few landed and export oriented farmers in these areas have had their interest captured (Allal and Edmonds, 1977; Barwell *et al.*, 1985; ILO, 1963). These studies explored methods which emphasised the achievement of low construction costs while building rural roads by adopting low-speed natural alignment for the road, using local, labour intensive technology where possible and minimizing the cost of earth moving. Others have highlighted that in addition to conventional motor vehicles, such roads may be used by a range of much simpler vehicles, including wheelbarrows and handcarts, animal drawn carts and bicycles (Heierli, 1993; Howe 1997). These studies, which primarily focussed on rural roads in developing countries, revealed that subsistence-related tasks dominated travel in the areas with most households possessing no form of vehicular transport and that there is an overall dominance of simple means of transport – i.e. walking, cycling, animal-powered (Barwell *et al*, 1985; Howe, 1983). These studies brought to fore the idea of local transport systems in the rural areas, which had previously been ignored in rural road planning and development programmes put forward by national and international funding/lending agencies originations. A system which included footpaths, tracks and un-engineered earth roads, and a variety of means of movement from walking through animal-powered and pedal-powered vehicles to simple machines. A key persuasion point was that the issue was not of problem of access that would be solved through provision of roads but a need to secure a fairer distribution of resources to the rural poor (Howe and Richards, 1984). To some extent these studies succeeded in broadening international funding agendas of organisations, such as the World Bank and ILO, to allow for consideration of the rural poor's lack of vehicle access and need for inclusive road usage planning.

To desire development via roads is not merely because of its promises of modernity and spatial integration between the centre and peripheral spheres of nation (Harvey and Knox, 2008; Moran, 2009), roads are also a means through which of city beautification and urban development are legitimised (Anand, 2006; Ellis, 1998). Managing urbanization in an epoch where rural to urban migration has accelerated and where urbanisation is associated with poor environmental conditions and slum or squatter

settlements (Anand 2006). Additionally, urban excess is also allied with high levels of air pollution originating from industrialisation and transportation, and has attracted growing attention from government, civil society, and industry in South Asian countries (United Nations Environment Programme, 2009). The promises of roads is then also about its purported ability to transform urban spaces ensnared in congestion and pollution to mega cities or world class cities devoid of either congestion or pollution. The role "cities and urban infrastructural networks play in energy consumption and the emission of greenhouse gases and that, as a consequence, cities are potentially important sites for political action around energy transition" though registered in the literature (Bridge et al. 2013:336), is usually neglected by policy-planners in the promise of road development in urban spaces (see also Coutard and Rutherford, 2010).

The World Bank (1996) argues for a reduction of the damaging environmental effects of motorized transport by promoting low consumption vehicles including non-motorised transport and participatory road planning methods. While the environmental consequences of infrastructural developments are extensive and complex, there are also cumulative consequences that result in "additive, multiplicative or synergetic effects" (Wasike, 2001:16). Assessing the intricacies of these impacts is likely to require an extensive knowledge of ecological principles and mechanisms; an illustration includes migration and land clearing, following construction leading to the severe structural loss of the forest and alterations in surface and subsurface water movement (Harvey and Knox, 2015; Ioris, 2010; Staddon, 2009; Wasike, 2001). Several other instances are likely to exemplify the overlapping scales of analysis needed for assessing the bearing of road infrastructure on the environment.

As energy security, whether food, water or fuel, scores high on the climate change agenda, the pressures upon natural resources through road infrastructure projects ought to be high on the policy governance agenda. The extent to which the development of road infrastructure are associated with energy systems, however, needs further research and exploration; the environmental governances that Bridge and Perreault (2009) calls for, point to how formal and informal scales at which decisions regarding nature are made. In arguing this, they remind us that governance happens at multiples sites and scales - state and non-state actors – in allocating, administering and regulating environment and resources. This

extends governance beyond those of formal institutions to include practices and norms through which key categories – nature, environment, citizens and resources – are contested, affirmed and reproduced. Reminding us that "resources struggles are never only about resources" but also about "the meanings of development, citizenship and the nation itself", they show how social movements have sought to reclaim the sites and infrastructures of hydrocarbon production by turning them into "spaces of nation-making" (Bridge, 2011:825; see also Perreault, 2006). Despite likely environmental and energy consequences, roads continue to be embraced in full force in the global South as infrastructures that promise development.

Conclusion:

The scholarship on infrastructure and development is diverse and vibrant, yet our review ascertains how road infrastructure has retained a sustained central policy plank through several decades. Our review on roads signals the need for development studies to remain engaged and in productive dialogue with geographers, anthropologists, development economics and sociologists alike. Geographers in particular may have an important contribution to make given its early entry to debates on climate change and energy transition. Because road development continues to be viewed as a means to enhance economic growth, there is scope for development studies to continuously review this standpoint with current pressing need to reduce emissions and energy consumptions. Relentlessly enhanced road density and high investments in motorised transport are still considered catalytic for development even when the environmental costs of this approach may be high. The benefits claimed to result from this process are not necessarily sustainable for rural development. The permanent loss of land for the rural poorest and the destruction of the remaining forested areas need to be further studied and highlighted for future development policy initiatives to be different.

Contributions by geographers that trace the attentiveness needed for energy transition (see Bridge et al. 2013), offer the possibility to reinvent the research field around road infrastructure and move discussions in new directions. They signal new possibilities, concepts, ideas, approaches and data to bear on the study roads and development more broadly. Entangled flows between roads, environment and

energy are hard to miss at the contemporary juncture of development studies. Recurrent assessments of concerns of road development to the workings of economic growth must also embrace the costs of climate change and the need for energy transition, including for economistic reasons. They point to the need to rearticulate a vision of mobility less dependent on roads and more on transportation of and for the public – a lacuna sorely lacking in development vision(s) around roads. To realise this goal, there needs to be not just further research around the environment and energy consequences of roads but also conversations with transport engineers because to underscore how development policies around infrastructure needs to be attentive to current environment and energy challenges. Articulating and examining these gaps is therefore a necessary and urgent task for social science scholars working in the realm of development studies.

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The Authors declares that there is no conflict of interest

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